

# Claims

- [c1] A method of manufacturing a metal UMoly mask for an integrated circuit chip interconnect solder bump, said method comprising:
- depositing a photoresist on both sides of a molybdenum foil sheet, wherein said molybdenum foil sheet is approximately 8 mils thick and said photoresist is approximately 12 microns thick;
- exposing and developing said photoresist to have at least one opening having a diameter of approximately 4 mil; and
- simultaneously etching both sides of said molybdenum foil sheet using an etchant spray pressure of approximately 5 psi.
- [c2] The method in claim 1, wherein said etching process produces a via in said molybdenum foil sheet that has a diameter of approximately 12 mil and a knife-edge of approximately 0.2 mil.
- [c3] The method in claim 1, wherein said etching process undercuts molybdenum adjacent said photoresist, leaving an unsupported edge of said photoresist after completion of said etching process.

- [c4] The method in claim 3, further comprising adjusting the pH of said etchant spray at least three times during said etching process to maintain the etching rate.
- [c5] The method in claim 4, wherein said process of adjusting the pH of said etchant spray comprises adding sodium hydroxide to said etchant spray.
- [c6] The method in claim 1, wherein said etching process further comprises monitoring and controlling:  
the concentration of molybdate complex;  
Fe concentration; and  
Oxidation/Reduction Potential (ORP).
- [c7] A method of manufacturing a metal TMoly mask for a tin-rich cap of an integrated circuit chip interconnect solder bump, said method comprising:  
depositing a photoresist on both sides of a molybdenum foil sheet, wherein said molybdenum foil sheet is approximately 4 mils thick and said photoresist is approximately 12 microns thick;  
exposing and developing said photoresist to have at least one opening having a diameter of at least approximately 7 mil; and  
simultaneously etching both sides of said molybdenum foil sheet using an etchant spray pressure of approxi-

mately 5psi.

- [c8] The method in claim 7, wherein a first photoresist on a first side of said molybdenum foil sheet comprises an approximately 7 mil diameter opening and a second photoresist on a second side of said molybdenum foil sheet comprises an approximately 11 mil diameter opening.
- [c9] The method in claim 8, wherein said etching process produces an asymmetric via that is smaller on said first side of said molybdenum foil sheet when compared to said second side of said molybdenum foil sheet.
- [c10] The method in claim 7, wherein said etching process undercuts molybdenum adjacent said photoresist, leaving an unsupported edge of said photoresist after completion of said etching process.
- [c11] The method in claim 10, further comprising adjusting the pH of said etchant spray at least three times during said etching process maintain the etching rate.
- [c12] The method in claim 11, wherein said process of adjusting the pH of said etchant spray comprises adding sodium hydroxide to said etchant spray.
- [c13] The method in claim 7, further comprising removing said

photoresist after said etching process.

[c14] The method in claim 7, wherein said etching process further comprises monitoring and controlling:  
the concentration of molybdate complex;  
Fe concentration; and  
Oxidation/Reduction Potential (ORP).

[c15] A method of manufacturing a metal UMoly mask for an integrated circuit chip interconnect solder bump, said method comprising:  
depositing a photoresist on both sides of a molybdenum foil sheet, wherein said molybdenum foil sheet is approximately 8 mils thick and said photoresist is approximately 12 microns thick;  
exposing and developing said photoresist to have at least one opening having a diameter of approximately 4 mil; and  
simultaneously etching both sides of said molybdenum foil using an etchant spray pressure of approximately 5 psi,  
wherein said etching process forms at least one via in said molybdenum foil sheet, and wherein said via has a diameter of approximately 12 mil and a knife-edge of approximately 0.2 mil.

[c16] The method in claim 15, wherein said etching process

undercuts molybdenum adjacent said photoresist, leaving an unsupported edge of said photoresist after completion of said etching process.

[c17] The method in claim 16, further comprising adjusting the pH of said etchant spray at least three times during said etching process to prevent damaging said unsupported edge of said photoresist.

[c18] The method in claim 17, wherein said process of adjusting the pH of said etchant spray comprises adding sodium hydroxide to said etchant spray.

[c19] The method in claim 15, further comprising removing said photoresist after said etching process.

[c20] The method in claim 15, wherein said etching process further comprises monitoring and controlling:  
the concentration of molybdate complex;  
Fe concentration; and  
Oxidation/Reduction Potential (ORP).

[c21] A method of manufacturing a metal TMoly mask for a tin-rich cap of an integrated circuit chip interconnect solder bump, said method comprising:  
depositing a photoresist on both sides of a molybdenum foil sheet, wherein said molybdenum foil sheet is approximately 4 mils thick and said photoresist is approxi-

mately 12 microns thick;  
exposing and developing said photoresist to have at least one opening having a diameter of at least approximately 7 mil; and  
simultaneously etching both sides of said molybdenum foil using an etchant spray pressure of approximately 5 psi,  
wherein said etching process forms at least one via in said molybdenum foil sheet, and wherein said via has a diameter of approximately 10 mil to 14 mil.

- [c22] The method in claim 21, where a first photoresist on a first side of said molybdenum foil sheet comprises an approximately 7 mil diameter opening and a second photoresist on a second side of said molybdenum foil sheet comprises an approximately 11 mil diameter.
- [c23] The method in claim 22, wherein said etching process produces an asymmetric via that is smaller on said first side of said molybdenum foil sheet when compared to said second side of said molybdenum foil sheet.
- [c24] The method in claim 21, wherein said etching process undercuts molybdenum adjacent said photoresist, leaving an unsupported edge of said photoresist after completion of said etching process.

- [c25] The method in claim 24, further comprising adjusting the pH of said etchant spray at least three times during said etching process to prevent damaging said unsupported edge of said photoresist.
- [c26] The method in claim 25, wherein said process of adjusting the pH of said etchant spray comprises adding sodium hydroxide to said etchant spray.
- [c27] The method in claim 21, further comprising removing said photoresist after said etching process.
- [c28] The method in claim 21, wherein said etching process further comprises monitoring and controlling:  
the concentration of molybdate complex;  
Fe concentration; and  
Oxidation/Reduction Potential (ORP).
- [c29] A metal UMoly mask used for manufacturing an integrated circuit chip interconnect solder bump, said mask comprising:  
a molybdenum foil sheet that is approximately 8 mils thick; and  
at least one via in said molybdenum foil, and wherein said via has a diameter of approximately 12 mil and a knife-edge of approximately 0.2 mil.
- [c30] A metal TMoly mask used for manufacturing a tin-rich

cap of an integrated circuit chip interconnect solder bump, said mask comprising:  
a molybdenum foil sheet that is approximately 4 mils thick; and  
at least one asymmetric via in said molybdenum foil sheet, wherein said asymmetric via has a 10 mil opening on a first side of said molybdenum foil sheet and a 14 mil opening on a second side of said molybdenum foil sheet.